AECM 0502 INVESTIGATIVE REPORT

TRITIUM OXIDE EXPOSURE INCIDENT

OAK RIDGE NATIONAL LABORATORY

OCTOBER 28, 1963

PART I

DATE: December 12, 1963

I. INTRODUCTION, AUTHORITY AND SUMMARY

The ORO-AEC was notified on November 1, 1963, that [redacted] (identified below) an employee of the Oak Ridge National Laboratory, operated by Union Carbide Corporation, a cost-type management contractor, had received an exposure to tritium oxide which resulted in a body burden of ~ 90 mc. This incident occurred on October 28, 1963, while the employee was working in a chemical hood, replacing two silver chloride windows of an infrared absorption cell from which tritium oxide had been removed six days previously. A fraction of the residual tritium oxide which had become "fixed" to the interior surfaces of the cell diffused out of the hood and into a laboratory during performance of the work.

An investigating committee appointed pursuant to the provisions of AEC Manual Chapter 0502 with the committee members selected by F. R. Bruce, Director of Safety and Radiation Control, ORNL, and concurred in by AEC, found that the primary factors involved in this incident were inadequate hood maintenance, lack of hood low flow air alarms, and an ineffective tritium monitoring system.

As a result of this, the intake face velocity of the hood in which the cell windows were being replaced was operating at 20 linear feet per minute - 100 LFM minimum ORNL standard - which was too low to prevent diffusion of hood contents to the laboratory. The tritium monitor which was mounted at the hood face was not effective in detecting diffusion of tritium oxide from the hood.

II. COMMITTEE OPERATION

This committee consisting of three ORNL employees and one AEC employee was appointed on November 6, 1963, to investigate the circumstances surrounding the incident, determine the cause, and make recommendations to prevent occurrences of a similar nature.

To this end, a number of persons who had knowledge of or were involved in the incident were interviewed. Those interviewed were:

H. M. Butler, Applied Health Physics Radiation Surveyor - Area Leader

H. H. Abee, Applied Health Physics Section Chief - Environmental Monitoring

Gibson Morris, Assistant Superintendent, Plant and Equipment Division

H. E. Seagren, Superintendent, Plant and Equipment Division

C. H. Johnson, Radiation Control Officer - Leader Charge Spectrometry Group, Physics Division

H. W. Morgan, Group Leader, Spectroscopy Research, Physics Division, the experimenter in the incident.

The facility was visited on two occasions. The first time the whole committee examined the facility and on the second occasion a committeeman reviewed the facility and operation with the experimenter.

During the course of the investigation, the committee met six times to determine the facts surrounding the incident, to arrive at conclusions, and to make appropriate recommendations. The conclusions and recommendations are compiled in Part II of the "Investigation Report of a Tritium Oxide Exposure Incident."

III. DESCRIPTION OF FACILITY AND OPERATION

Chemical hood 219, equipped with a filtered ventilation system, is located in Laboratory E-57, Building 4500 South, and contains a vacuum facility (Fig. 1) for storage and handling of tritium and for the synthesis and handling of compounds containing tritium. The facility consists of three stainless steel containers 1" o.d. x 4" long, appropriately interconnected with a manifold made up of 1/4-inch copper tubing and stainless steel bellows valves (Teflon seated). A gauge and manometer for pressure indication and a vacuum pump are also included in the facility.

Two of the containers, containing finely divided uranium, are used for storing tritium as uranium hydride. The third container is used as a volume measurement and for transfer of tritium compounds. At room temperature the vapor pressure of tritium over uranium is less than 10^{-4} mm of mercury. Tritium is generated by heating the container to 250-400°C.

In the synthesis of tritium compounds, small batches of tritium, 30 curies or less, are processed in specially designed equipment attached to the above facility. Tritium compounds are moved through the vacuum system by cooling a receiver to 77°K, and are stored at low temperature.

Approximately 250 curies of tritium are presently stored in the uranium containers.

In the study of infrared spectra of tritium oxide, in cooperation with the University of Tennessee, somewhat less than 300 curies of tritium oxide have been synthesized and transferred to an absorption cell. The cell (Fig. 2), constructed in the shape of a "V", with a mirror at the intersection and a window at each of the ends, is fabricated of stainless steel with a short attached evacuation and fill line. On this copper line, separated from the cell by one valve, is a stainless steel cold finger in which the tritium oxide is isolated by freezing for storage when the cell is not in use. The windows, of rolled polycrystalline silver chloride, are flanged to the cell with O-ring gaskets.

For filling or emptying the cell, it is mounted in one end of the chemical hood and attached to the tritium handling system. Tritium oxide is transferred to or from the cell by cooling the appropriate container to 77°K. The vacuum pump is used only to evacuate air from new equipment.

Since silver chloride is not chemically compatible with radioactivity, the windows must be changed periodically to insure sufficient transmission of infrared radiation. In this operation, the tritium oxide is transferred to a container in the facility, and the cell then heated to 100°C to desorb as much tritium oxide from the cell as possible. Residual tritium then consists of a small amount adsorbed on the metal and window surfaces and that adsorbed and exchanged by the neoprene O-rings. The cell is then brought to atmospheric pressure with argon.

The replacement of both windows requires less than 30 minutes. The used windows and O-rings are placed in an air-tight container for disposal. After the replacement operation, the argon is removed from the cell by pumping through a trap at 77°K and into the vacuum pump. The tritium oxide recovered in this trap, plus that removed prior to changing the windows, is transferred back to the cell and stored in the cold finger until needed.

During normal operations, activity in the hood is monitored by a portable tritium counter (TSM-91) of high sensitivity, which is mounted at the face of the hood. Smears of the hood and surrounding area are taken at intervals by Health Physics personnel.

IV. CIRCUMSTANCES SURROUNDING THE INCIDENT

While the experimenter was replacing the silver chloride (AgCl) windows of the infrared absorption cell on October 28, 1963, residual oxide in the cell and/or adsorbed and exchanged by the O-ring seals escaped from the chemical hood in which the work was being performed, and into the laboratory. Present at the time as an observer was, Kenneth Leroy Vander Sluis, physicist and employee of ORNL, referred to hereafter as an "observer".

The experimenter considered the window replacement procedure (Exhibit 1, Part II) relatively straightforward because he had used it before, in May, 1963, with no detectable contamination of cell, chemical hood, or laboratory.

While the cell windows were being replaced, the experimenter noticed that the tritium counter (Type TSM-91) which was monitoring the work area showed some response. At the time he felt that the reading was due mainly to extraneous ions or dust particles and not to tritium.

When the work was completed, a Health Physics check was required because of the possibility that minute portions of the contaminated O-ring window seals could have dropped from the chemical hood to the floor. The smear tests indicated a relatively uniform contamination over the

floor, benches and equipment of the laboratory, with additional activity on the hood lip in front of the working area.

Surface smears indicated the following: (See Exhibit 2, Part II)

Elevated horizontal surface	- up to 7.5×10^4 T_2 d/m/smear
Floor	- up to 1×10^5 T_2 d/m/smear
East corridor hallway	- up to 2.4×10^4 T_2 d/m/smear
Hood-lip surface	- up to 4×10^5 T_2 d/m/smear

Contaminated areas were zoned with restricted area requirements and clean-up was started immediately. Urine specimens were obtained from the experimenter and observer to determine if an internal exposure had been sustained.

Since the uniform contamination suggested diffusion out of the chemical hood, the air flow was checked by Health Physics. The face velocity was found to be approximately 20% of minimum standard of 100 (LFM). The face velocity was later restored to more than 100 (LFM) by replacing the hood filter.

V. FINDING OF FACTS

A. While the experimenter was changing the windows of an infrared absorption cell in chemical hood 219 on October 28, 1963, residual tritium oxide in the cell or gasket material diffused out of the hood and into laboratory E-57. This resulted in a body burden of ~ 90 mc to the experimenter and general contamination of the laboratory and an adjoining corridor. An observer a few feet from the experimenter received a body burden of ~ 4 mc.

B. The escape of the tritium oxide into laboratory E-57 was not effectively detected by a TSM-91 tritium monitor mounted on the front face of the hood.

C. The intake face velocity of chemical hood 219 at the time of the incident was approximately 20 linear feet per minute. This face velocity was later restored to more than the required 100 feet per minute by replacement of a dirty filter.

D. Laboratory E-57 and the adjoining corridor were readily decontaminated.

E. The hood face velocity, last checked in June, 1963, did not receive its quarterly check in September because of lack of follow-up and liaison following an organizational change in responsibilities (see Exhibit 3, Part II) on July 25, 1963.

F. The experimenter had received the necessary approval for performing the operation in the chemical hood.

G. The experimenter assumed the hood draft was adequate because the hood was tagged for 100 LFM face velocity. The hood is not equipped with a low flow alarm.

H. The experimenter considered the replacement of the cell windows a relatively straightforward procedure because it was done before in May, 1963, without detectable contamination of cell, hood, or laboratory.

I. Building 4500 South does not have a central hood alarm system for monitoring the suction pressure of each hood.

Respectfully submitted:

E. O. Wollan, Chairman
Associate Director
Physics Division
Oak Ridge National Laboratory

H. V. Heacker
Health Physicist
Research and Development Division
U. S. Atomic Energy Commission
Oak Ridge Operations

A. J. Miller
Space Programs Coordinator
Oak Ridge National Laboratory

T. A. Arehart
Safety and Radiation Control Department
Oak Ridge National Laboratory

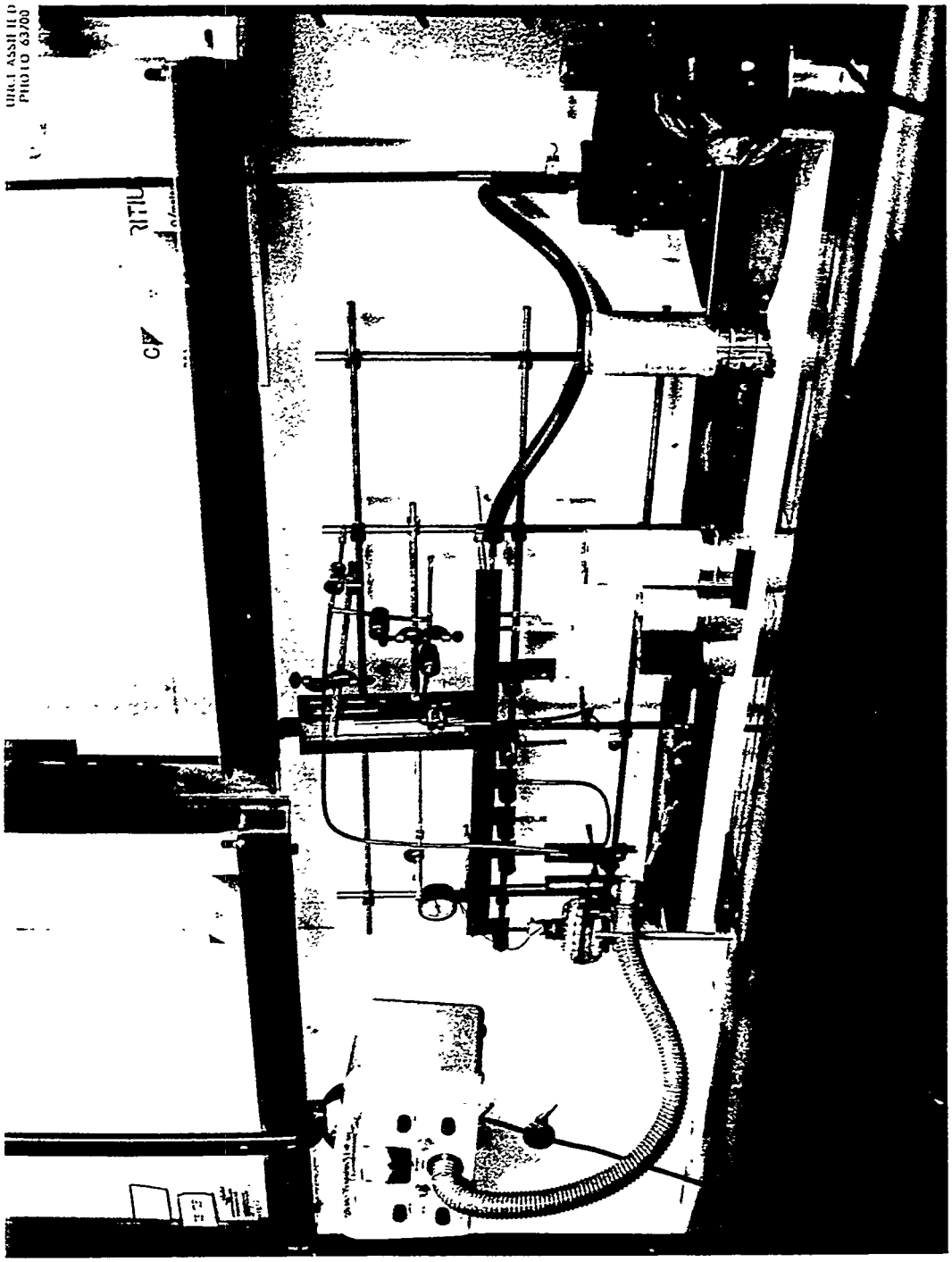

Figure 1

Figure 2